



## Circular to Industry CI-112D

# Light Vehicle Frontal Protection Systems Construction Guidelines

### Summary

This Circular applies to light vehicles with a gross vehicle mass (GVM) of no greater than 4.5 tonnes fitted with a frontal protection system (FPS).

It defines a West Australian (WA) Department of Transport (DoT) standard for the design and fitment of an FPS that provides an appropriate balance between the protection of vehicle occupants from animal strike and the safety of pedestrians.

Any light vehicle fitted with an FPS must continue to comply with all applicable Australian Design Rules and State requirements.

## INTRODUCTION

In this document, the term Frontal Protection System (FPS) includes Bull Bars, Roo Bars and Nudge Bars.

The purpose of this Circular to Industry (CI) is to define a WA Department of Transport (DoT) standard for FPS which informs manufacturers and retailers about the safety requirements applying to the design, specification and fitment of FPS to vehicles on WA roads.

This standard provides an appropriate balance between the protection of vehicle occupants from animal strike and the safety of pedestrians by offering clear guidance to help ensure that the right FPS is fitted to the right vehicle in the right way.

This revision of the CI does not introduce any new requirements for existing bullbar designs. The fundamental requirements of the CI have remained unchanged since 2005.

What the update does introduce, however, are certain prescriptive details to provide additional clarity for certain areas that were previously open to conjecture or mis-interpretation. As such,

- Any new vehicle model introduced after 1 July 2019 fitted with an FPS must comply with this CI.
- Any other light vehicle fitted with an FPS should continue to comply with this CI in the exact same manner as with the previous version of the CI.

## BACKGROUND

For many years, an FPS has been accepted as an accessory for most types of vehicle, often fitted to help protect a vehicle in the event of a crash with an animal, such as a kangaroo, by reducing the potential for damage to the cooling system and leaving the vehicle stranded after an impact. An FPS also helps provide additional frontal protection from scrub and bushes when driven off-road on overgrown bush tracks.

However, when a poorly designed FPS is fitted to a vehicle, it can be potentially dangerous to vulnerable road users such as pedestrians and cyclists in the event of a collision. In addition, the continued development of vehicle technology and ongoing improvements in vehicle safety systems have led to a situation whereby the fitment of a non-compliant FPS may actually interfere with the sophisticated safety systems designed into modern vehicles.

A great deal of research has been conducted into the possible effects of an FPS in a collision and ways of optimising their design. This DoT document has been produced following detailed technical investigations. It supports and builds upon the information contained within *Australian Standard AS 4876.1-2002 Motor vehicle frontal protection systems Part 1: Road user protection*, which primarily addresses the issue of minimising the risk of injury to pedestrians as a result of colliding with a vehicle fitted with an FPS.

# SAFETY

## Pedestrian Safety

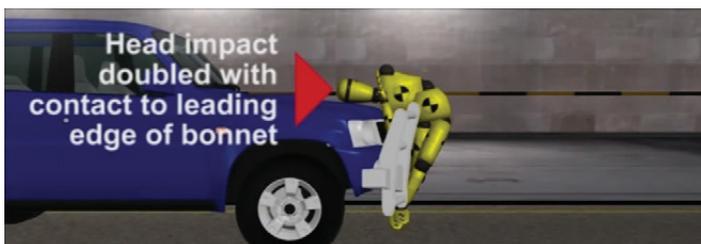
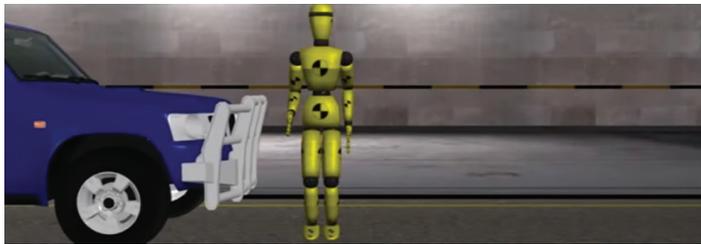
Accident statistics, confirmed by scientific studies, have shown that a poorly designed FPS greatly increases the risk of injury to a pedestrian hit by a car, even at relatively low speeds.

Generally the best scenario for the pedestrian, and when the severity of injury is minimised, occurs where the pedestrian rolls onto the bonnet of the car. The chances of this happening are better if the point of initial contact between car and pedestrian is as low as possible. One of the risks posed by a poorly designed FPS is that it will raise the point of initial contact and thereby increase the severity of a pedestrian injury.

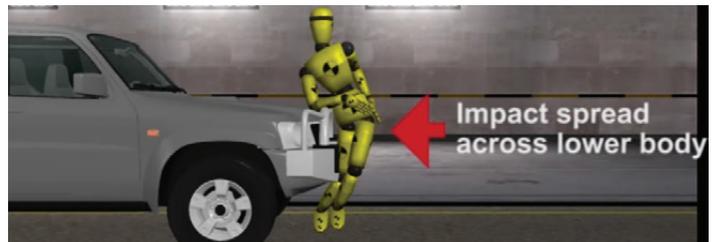
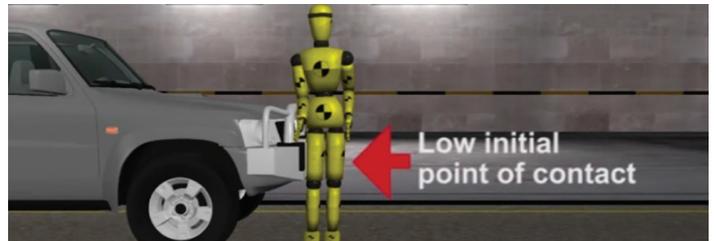
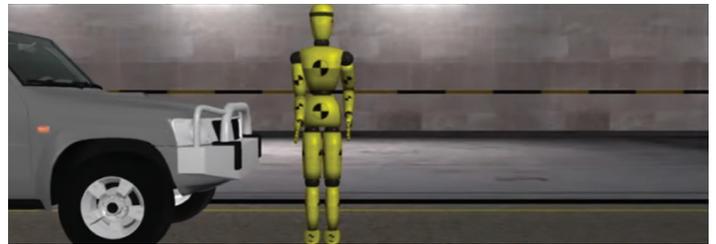
For vehicles fitted with an FPS, laboratory testing has confirmed the importance of FPS design to the outcomes of a pedestrian collision. The images below, taken from a computer simulation conducted by the Centre for Automotive Safety Research (CASR) at the University of Adelaide demonstrates that a compliant FPS results in lower pedestrian head impact speeds with the vehicle, reducing the severity of the impact and resulting in a reduction to the risk of a serious head injury by well over 50%.

Because the non-compliant FPS presents a higher point of initial contact, the pedestrian is pushed forward and bent around the top of the FPS, rather than being swept onto the bonnet of the car, resulting in a much higher risk of spinal, pelvic and head injuries to the pedestrian, even at relatively low collision speeds.

### Non-compliant design bullbar



### Compliant design bullbar



## Vehicle Occupant Safety

Over the last few years, there have been significant advances in the on-board safety systems fitted to new vehicles. The continued development of vehicle technology and ongoing improvements in vehicle safety systems have led to a situation whereby the fitment of an FPS may actually interfere with the sophisticated safety systems designed into modern vehicles.

The main causes of concern are outlined as follows:

- **Incompatibility with vehicle air bags**

A poorly designed FPS may affect the triggering of the airbag sensors in the event of a crash, causing the air bags to activate at the incorrect time. In the worst case, this can cause significant additional injury to the occupant.

- **Nullification of crumple zones**

Modern vehicles have crumple zones that protect the occupants by cushioning the impact of a front-end collision. A poorly designed FPS has the potential to make the front end of the vehicle significantly more rigid, thereby reducing the effectiveness of the crumple zones. This causes a more severe impact for the occupants of all vehicles involved.

- **Incompatibility with other vehicles**

At an international level, significant research is being undertaken towards improving the “crash compatibility” between vehicles involved in vehicle-to-vehicle collisions. The aim of this research is to design vehicles in such a manner that maximises each vehicle’s ability to absorb crash energy. A poorly designed FPS can negate these design features, thus increasing the risk of more significant injuries to the occupants of other vehicles involved in the collision, than would have been the case had the colliding vehicle not been fitted with a FPS.

### Safety Rating of a Vehicle fitted with an FPS

DoT recommends that consumers seek advice from the supplier that the FPS is compliant with *AS 4876.1-2002 Motor vehicle frontal protection systems Part 1: Road user protection*, and therefore the vehicle, when fitted with the FPS, continues to comply with all applicable Australian Design Rules.



# FRONTAL PROTECTION SYSTEMS FOR LIGHT VEHICLES

This CI applies to vehicles with a gross vehicle mass (GVM) of no greater than 4.5 tonnes.

Every FPS must be designed to minimise the risk to pedestrian safety and the likelihood of penetrating into other vehicles in the event of a crash by adhering to the following guidelines.

## Initial Point of Contact

The initial point of contact between the bull bar and pedestrian in the event of a collision should be as low as possible.

### For all new vehicle models from 1 July 2019

#### As defined in Diagram 1:

- The FPS must reside in the green shaded area.
- The initial point of contact must not be higher than the Horizontal Split Line (yellow line).
- The Horizontal Split Line is coincident with the line used to determine the minimum height of the dipped beam headlamp above the ground on an unladen vehicle\* which, as defined in *Installation of Lighting and Light Signaling Devices on other than L-Group Vehicles*, is measured from the bottom of the illuminating surface. (\*The position of the Horizontal Split Line relative to the vehicle remains unchanged as the vehicle ride height changes eg the vehicle is laden or fitted with modified suspension. All vehicles still need to comply with the ADR height requirements for headlights.)
- The Upper Set-back Line (blue line) starts at the junction of the Vertical Initial Contact Line (green line) and the Horizontal Split Line (yellow line) and is set back 5 degrees to the vertical.

#### As defined in Diagram 2:

- The structure that joins the FPS main channel and upper structure or tube is referred to as the 'upright'. The upright shall not have any lower scuttle bar or forward attitude below the initial contact point. The projection of the profile moving down from the initial contact point can move rearward or vertically but not forwards.

## Height of the FPS

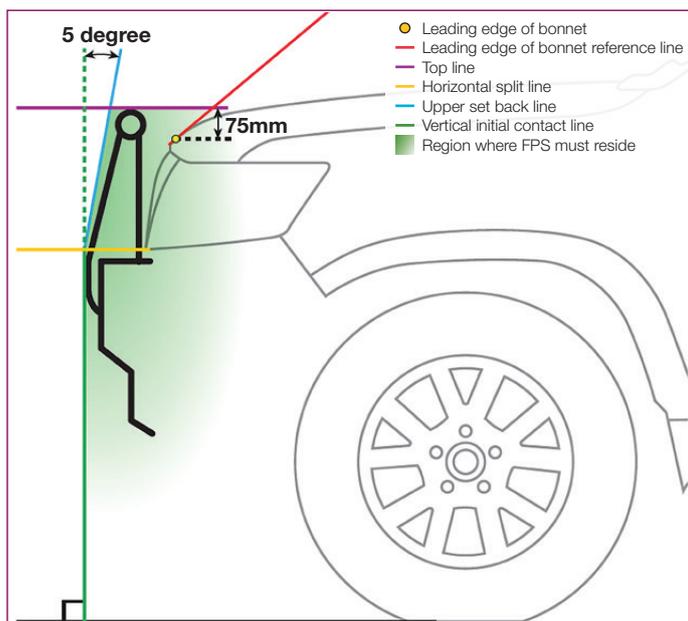
The FPS upper structure should be designed to be as low as possible to minimise the danger to pedestrians in the event of a collision, as well as minimising the impact on vehicle airflow and non-safety critical functions such as parking cameras and sensors. The top of the FPS should not protrude above the front of the bonnet line.

The operation of native (OEM) safety features such as headlight ADR performance requirements or distance sensors (radar etc.) must not be affected by the FPS fitment.

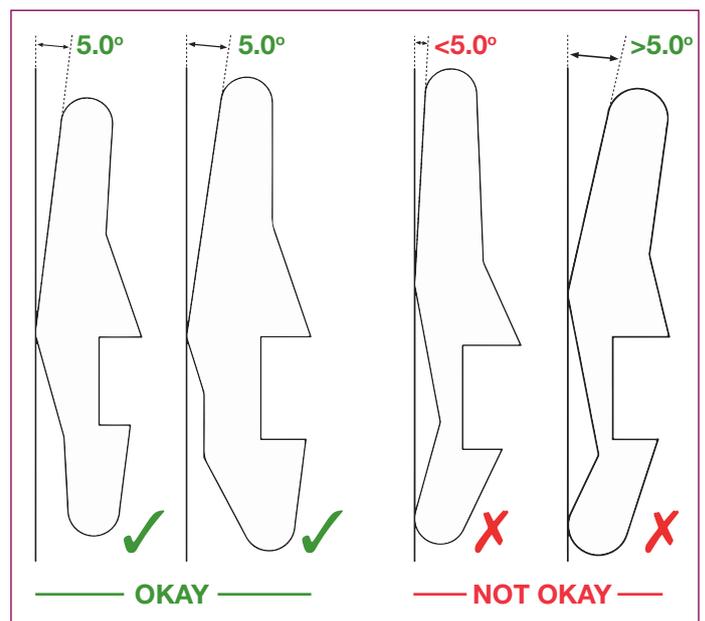
### For all new vehicle models from 1 July 2019

#### As defined in Diagram 1:

- No part of the FPS can be more than 75mm above the leading edge of the bonnet when measured at the centre-line of the vehicle, as defined by the Top Line (purple line) in Diagram 1.
- In addition, when the FPS is fitted to the vehicle, the field of view requirements (see Diagram 4) must continue to be met.



**Diagram 1** - Defined area (shaded green) within which the FPS profile must reside.

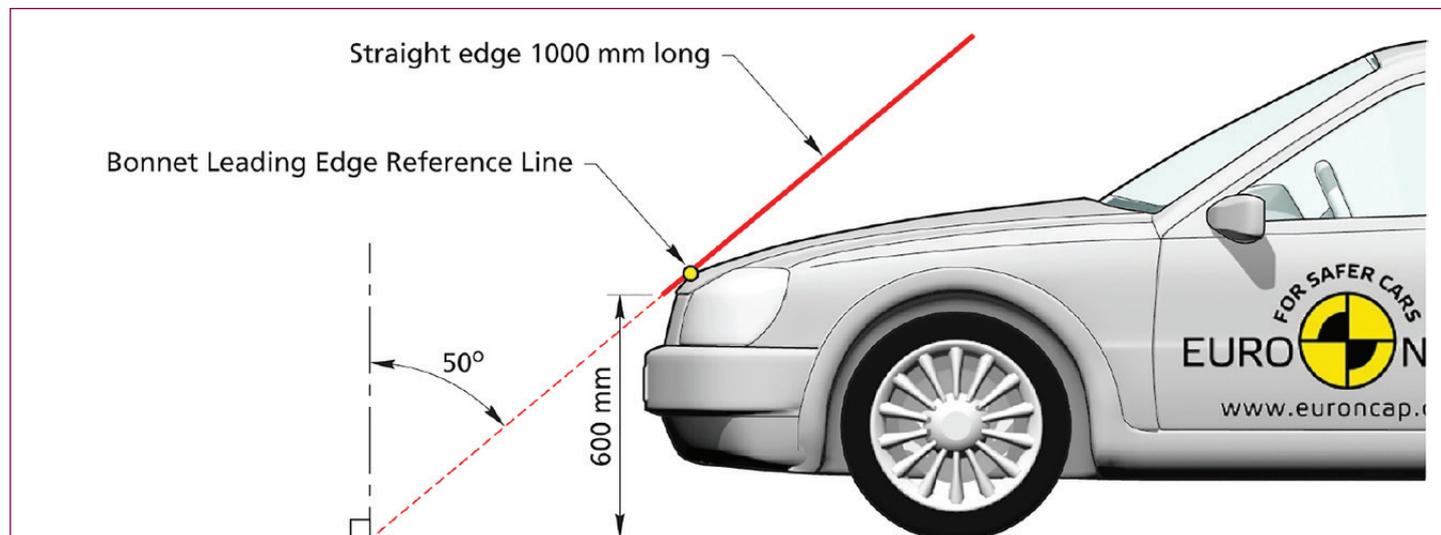


**Diagram 2** - Examples of acceptable and unacceptable upright profiles.

### Determination of the leading edge of the bonnet

ANCAP Test Protocol Pedestrian Protection v8.5 (Jan. 2019, P.15) defines the “Bonnet Leading Edge Reference Line” as shown in Diagram 3.

The definition, which can be used as a guide to determine the leading edge of the bonnet, is as provided in UN Regulation No. 127 which lays down requirements for the construction and functioning of motor vehicles and frontal protection systems in order to reduce the number and severity of injuries to pedestrians and other vulnerable road users.



**Diagram 3** - Determination of the bonnet leading edge reference line.

In conjunction with the requirements for top tube height limits as outlined in Diagram 1, the FPS top protection structure may have an upward trajectory towards the outer edges of the vehicle to allow clearance for the headlight beams and protection of the leading edge of the bonnet.



**Figure 1** - Example leading edge of the bonnet.



**Figure 2** - Example of upward trajectory of FPS.

### FPS to follow frontal profile of the vehicle

To minimise the risk of increased pedestrian injury, the whole FPS must conform to the frontal profile of the vehicle to which it is fitted.

Put simply, the FPS must follow the shape, in plan view, front view and side view, of the front of the vehicle.

The side profile of the FPS must not be any steeper than the side profile of the front of the vehicle. The FPS must not lean forward.

### For all new vehicle models from 1 July 2019

#### As defined in Diagram 1:

- The FPS upper structure must have a minimum rearward rake angle of 5 degrees from vertical.



**Figure 3** - Examples of acceptable FPS designs.

The maximum distance from the leading edge of the bonnet to the inside of the FPS should not exceed 200mm where practicable. Suggested measurement positions are shown by red arrows above.

## Dangerous Projections

Existing provisions in the *Road Traffic (Vehicle) Regulations 2014*, relevant to FPS design, prohibit dangerous projections and sharp corners. The FPS must be designed so as to prevent the hooking or grazing of other road users:

- Exposed edges need to be chamfered and free of burrs or sharp edges
- Forward facing edges must have radii not less than 5mm
- Open ended frame members are not permitted

Where the front bumper of the vehicle is removed to allow an FPS to be fitted, the design of the FPS must not cause any dangerous projections, for example by exposing sharp chassis rail edges and components such as bolt threads that were previously masked by the OEM bumper bar or air dam / spoiler.



**Figure 4** - Example of exposed edge creating a dangerous projection.

To provide further clarity in determining what constitutes a dangerous projection, the following methodology, taken from *ADR 92/00 - External Projections*, should be adopted.

As per the provisions of ADR 92/00, a dangerous projection is defined as any part of the external surface with a forward facing radius less than 5mm which, with the vehicle in the laden condition, with all doors, windows and access lids etc., in the closed position, is:

1. Above the floor line, as defined in ADR 92/00;
2. At a height of no more than 2 metres; and
3. So located that, in its static condition as well as when in operation, it can be contacted by a sphere 100 mm in diameter.

Recovery points and brackets should be fitted at a minimum distance of 100mm behind the front face of the FPS and be free of burrs and sharp edges.

### **For all new vehicle models from 1 July 2019**

- The vehicle must comply with the requirements of ADR 92/00.

## FPS in conjunction with other vehicle modifications

A vehicle that is compliant when fitted with a FPS may no longer comply if the vehicle is subsequently modified.

For example, the combined effect of a vehicle suspension lift and fitment of an FPS may compromise compliance with ADR requirements for wheel coverage.

Please contact DoT's Vehicle Safety & Standards section if you require any further advice on vehicle modifications.

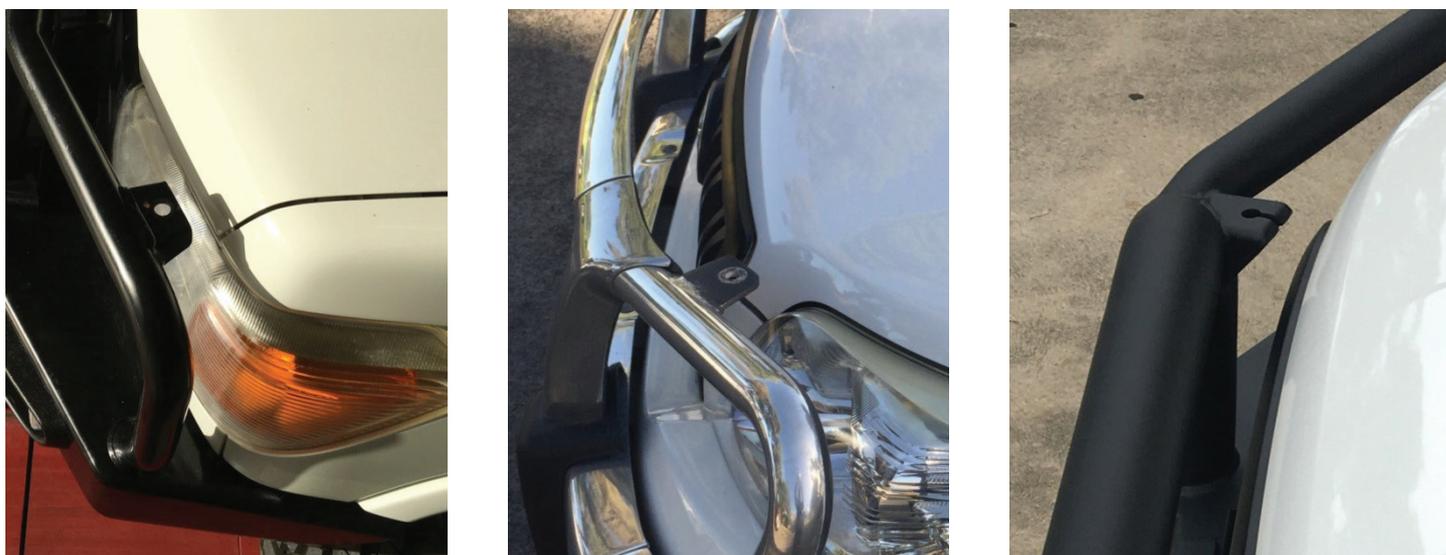


**Figure 5** - Example of non-compliant vehicle.

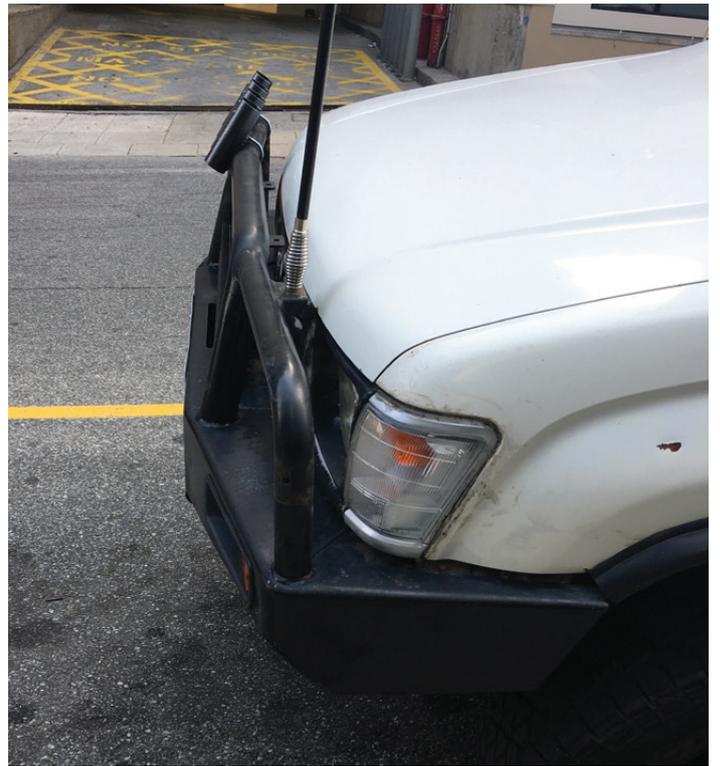
## Attachments and Attachment Points on an FPS

It is acceptable to have attachment points fixed to an FPS for items such as aerials and driving lights provided they are only fixed rearward of the front face of the FPS in a manner that prevents them from becoming dangerous projections.

Similarly, fishing rod holders may only be fitted if they do not protrude forward of the front face or above the top bar of the FPS to which they are fitted and do not become a dangerous projection.



**Figure 6** - Examples of acceptable attachment points on an FPS.



**Figure 7** - A rod holder mounted as shown is a dangerous projection and is not acceptable.

## Vehicle Lighting

The installation of an FPS may result in the existing lighting being obscured and consequently prevent the vehicle from complying with *ADR 13 - Installation of Lighting and Light Signaling Devices on other than L-Group Vehicles*.

Where ADR lighting requirements are not satisfied, additional ADR compliant lamps must be fitted.



**Figure 8** - Examples of acceptable additional lighting on an FPS.

## Field of View

Any FPS, together with any attachments, must not reduce a driver's ability to safely drive the vehicle to which it is attached.

When sitting in the driver's seat with the seat located at its rearmost position, it shall be possible to see the surface of the road 11 metres in front of the driver's eye looking across the top of the FPS as shown below.

For the purposes of this requirement, the driver's eye position can be taken as being a point 730mm above and 270mm forward of the junction of the seat cushion and squab (back) with the seat in its lowest and rearmost position;

Driving lights and other accessories that will obscure the driver's field of view must not be attached to the top rail of an FPS.

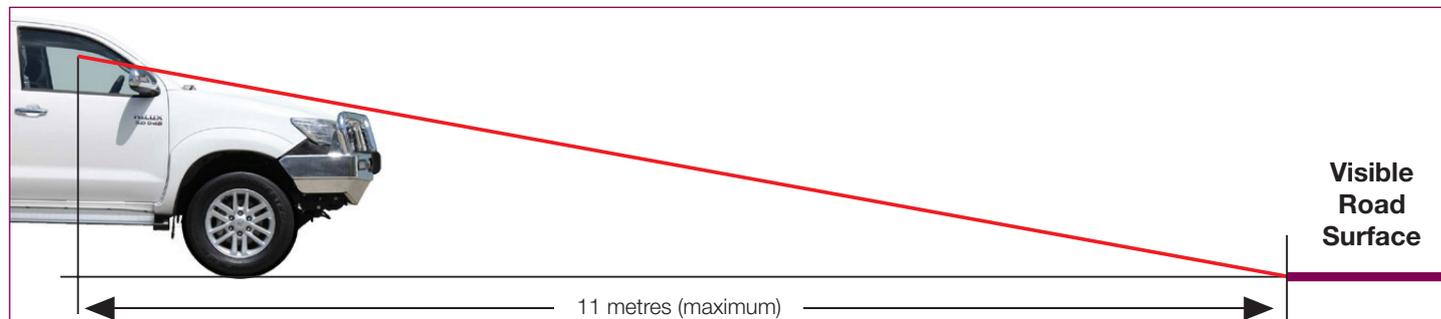


Diagram 4 - Field of view

## Front Axle Load Rating

The maximum front axle weight of the loaded vehicle fitted with an FPS and any accessories must not exceed the manufacturer's front axle load rating.

## Manufacturer's Safety Equipment

Any FPS fitted to a vehicle must not render ineffective the operation of any safety features fitted to the vehicle by the vehicle manufacturer.

## Continued compliance with all Federal and State requirements

Any vehicle fitted with an FPS must continue to comply with all applicable Australian Design Rules and State requirements.

## Approval Requirements

Any FPS that complies with the requirements of this CI is considered to be an acceptable vehicle modification that does not require the owner of the vehicle to obtain a "Modification Permit" from the Department of Transport (DoT). Manufacturers or suppliers who fit a complying FPS therefore do not need to seek prior approval before fitting these to road vehicles.

Any FPS that does not comply with this CI risks failing a vehicle inspection or being issued with a defect notice by on-road enforcement officers and may be required to be removed from the vehicle.

If there is any doubt that the fitment of a particular FPS design may not comply with this CI, suppliers or manufacturers must contact the Vehicle Safety and Standards Section of DoT before fitting the FPS.

If the application is considered to be acceptable, given the particular circumstances, the FPS installation may be approved, or the design itself may be approved for use on certain vehicles.

## Selection of a suitable FPS

When purchasing an FPS, consumers are strongly advised to select a design of FPS that not only meets the design requirements of this CI, but which is suitable for their driving requirements.

A style of FPS such as a nudge bar (below, left) may be more appropriate to a vehicle that spends the majority of its time in the metro area. For vehicles that travel extensively on country roads, the more traditional bull bar design (below, right) may be more suitable.



Figure 9 - Example of nudge bar



Figure 10 - Example of bull bar

## Fitment of FPS to ADR 69/ and ADR 73/ Vehicles

Australian Design Rule ADR 69/ and ADR 73/ set minimum levels of occupant protection, as determined by crash testing. Depending on the design and application, an FPS may positively or negatively affect occupant safety in a crash situation.

### ADR 69/ affects the following vehicles:

- from 1 July 1995, all new model MA vehicles (passenger cars);
- from 1 January 1996, all MA vehicles (passenger cars);
- from 1 January 1998, all new model MB vehicles (forward control passenger vehicles), and all new model MC vehicles (off-road passenger vehicles);
- from 1 July 1998 for new model NA1 vehicles (light goods vehicles);
- from 1 January 2000 all MB vehicles (forward control passenger vehicles), and all MC vehicles (off-road passenger vehicles); and
- from 1 July 2000 all NA1 vehicles (light goods vehicles).

### ADR 73/ affects the following vehicles:

- from 1 January 2000, all new model MA vehicles (passenger cars); and with a Gross Vehicle Mass (GVM) of less than 2.5 tonnes; and
- from 1 January 2004, all MA vehicles (passenger cars); and with a GVM of less than 2.5 tonnes.

For these vehicles, FPS manufacturers will need to provide evidence that the fitment of their product does not interfere with the intent of the occupant protection provisions specified in ADR 69/ and ADR 73/. (e.g. by conducting physical tests or computer simulations).

Air bags may be fitted by vehicle manufacturers in order to comply with ADR 69/ and ADR 73/ or as an additional safety feature at the manufacturer's discretion. The triggering methods used to deploy the air bags vary greatly in complexity between manufacturers. The fitting of an FPS to the front of a vehicle may have an unknown effect on the deployment characteristics of an air bag. FPS manufacturers will need to demonstrate that the fitment of their product does not adversely interfere with the triggering of the air bag system.

Research to date indicates that the strength of the mounting points is one of the most significant parameters of the FPS's potential to interfere with the vehicle's crashworthiness. The research has shown that carefully designed mounting points result in little or no effect on the vehicles ability to satisfy ADR 69/ and ADR 73/.

FPS manufacturers should acquaint themselves with this information and ensure that their FPS designs comply with these requirements. Manufacturers should utilise the services of a professional engineer if required to assist them in interpreting this data and applying it to their designs.

If the FPS can be fitted with additional bush-rails / scrub bars, then any testing undertaken should include their fitment.

## FPS Labeling

Every conforming FPS shall have a durable plastic or metal plaque permanently attached by bonding, riveting, welding, drive screws, or a durable integral label, on a surface of the bar such that the label can be read when the FPS is attached to a vehicle and located where it will not sustain environmental damage.

It shall display the following information in permanent and legible letters not less than 4 mm high:

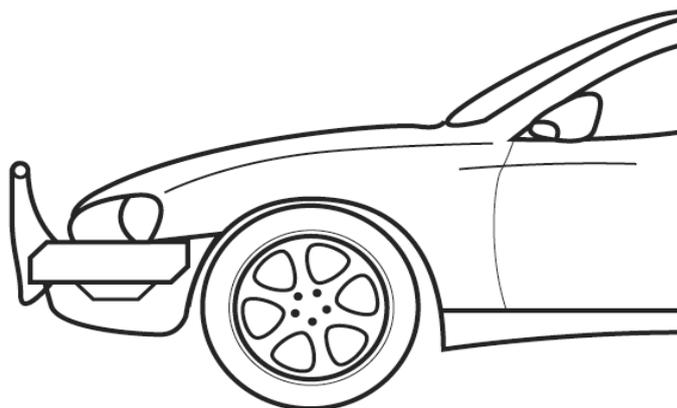
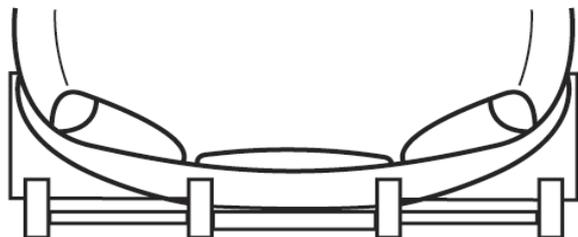
- A description indicating the vehicle make and year model(s) for which the FPS is suited
- The FPS manufacturer's business name
- An identification code that permits the manufacturer (or importer) to identify a specific production batch
- The statement "This product and the associated fixings must not be modified"
- A statement to confirm that the vehicle continues to comply with all applicable ADRs\*.

\*As per the requirements of the *Road Traffic (Vehicles) Regulations 2014 Part 10 Division 4 – Compliance with Australian Design Rules*.

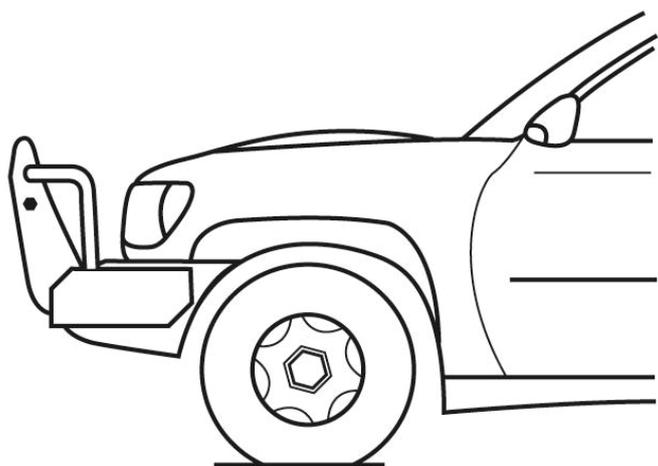
FPS labelling that complies with the requirements of AS 4876.1-2002 *Motor vehicle frontal protection systems Part 1: Road user protection, Section 1.4 - Marking* will be deemed to be an acceptable alternative.

## Non-Compliant FPS Designs

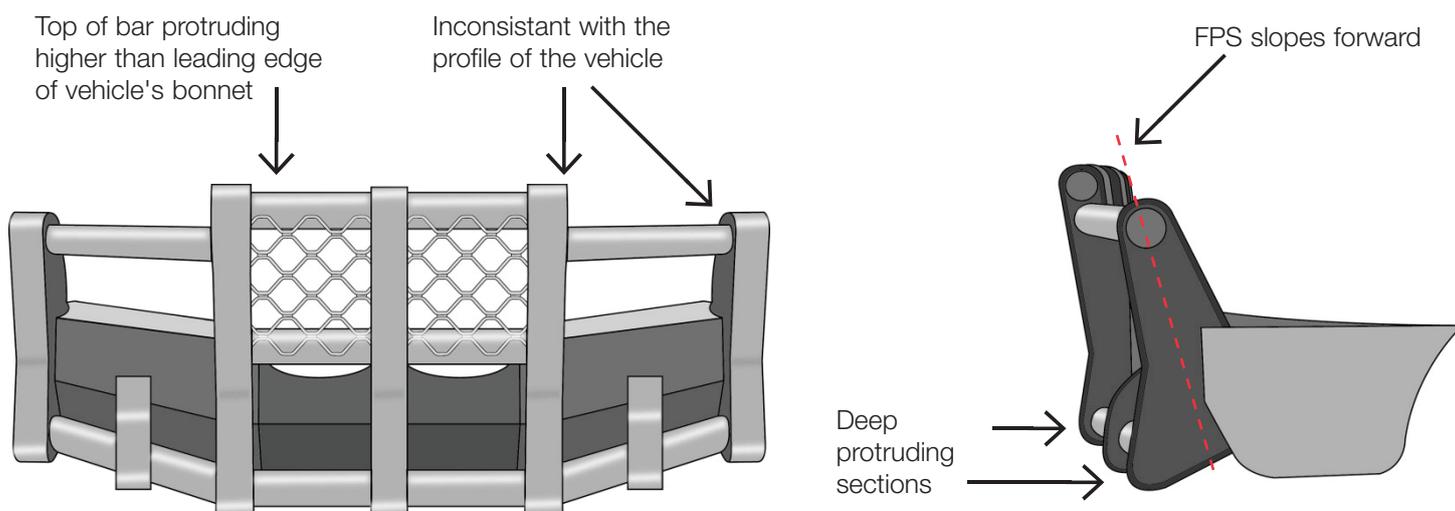
The following FPS designs do not meet the requirements of this CI.



**Figure 11** - FPS does not follow the front profile of the vehicle, the FPS is too high.



**Figure 12** - FPS leans forward on the vehicle, the FPS is too high.



**Figure 13** - FPS has unacceptable upright profile, the FPS is too high.

## FPS Checklist

Is each of the following statements correct?

<b>General Profile - All Vehicle Models</b>		<b>Y / N</b>
The FPS follows the shape, in plan, front and side view, of the front of the vehicle		
The FPS does not lean forward		
The top of the FPS does not protrude above the front of the bonnet line, where practicable		
<b>General Profile - All New Vehicle Models from 1 July 2019</b>		<b>Y / N</b>
The upper structure of the FPS is raked back a minimum of 5 degrees from vertical (refer to Diagram 1)		
No part of the FPS is more than 75mm above the leading edge of the bonnet when measured at the centre line of the vehicle (refer to Diagram 1)		
The side profile of the FPS uprights does not have a forward attitude below the initial contact point (refer to Diagram 2)		
<b>Projections and Sharp Edges</b>		<b>Y / N</b>
All brackets or other rigid components are fitted rearward of the front face and below the top of the FPS		
Any device attached to the FPS that protrudes above the top of the FPS does not have exposed sharp edges		
All forward facing edges are chamfered and free of burrs or sharp edges		
All forward facing edges have radius no less than 5mm		
The FPS is free of open ended frame members		
No dangerous projections have been exposed by the removal of the OEM bumper bar (if applicable)		
<b>Obscured lights</b>		<b>Y / N</b>
All the vehicle lights are unobscured by the FPS or additional ADR compliant lights are fitted		
<b>Number Plate</b>		<b>Y / N</b>
The number plate and any mounting hardware is free from sharp edges		
The number plate mounting position meets all visibility requirements		
<b>Field of View</b>		<b>Y / N</b>
A driver in the rearmost driving position has an unobstructed view of the road at all points beyond 11 metres in front of them (refer to Diagram 4)		
<b>Labelling</b>		<b>Y / N</b>
The FPS is correctly labelled		

If the answer is “No” for any of the above statements, the FPS does not comply with the requirements of this CI.

## Acknowledgements

The Department of Transport would like to thank the following organisations for their participation in the development of this Circular.



Australian Automotive Aftermarket Association



Motor Trade Association Western Australia

## Document history (version control)

Version Number	Date
CI - 1995 - 200	May 1995
CI - 1995 - 201	March 1998
CI - 112A	November 2003
CI - 112B	July 2005
CI - 112B	June 2010
CI - 112C	May 2015
CI - 112D	August 2019